

## Air Pollution and the Automobile



Ontario

Ministry of the Environment

Hon. J.A.C. Auld      Everett Biggs  
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## AIR POLLUTION AND THE AUTOMOBILE

Automobile exhaust can be dangerous and is a major source of air pollution. In addition to carbon dioxide and water vapor, it contains carbon monoxide, oxides of nitrogen, unburned hydrocarbons and lead.

Carbon monoxide concentrated in an enclosed space can be lethal. Less dangerous but still harmful amounts can build up in conditions of heavy traffic or from faulty exhaust systems.

Oxides of nitrogen and hydrocarbons react under the influence of sunlight to produce photochemical oxidants -- compounds that make the eyes smart and irritate throat and breathing passages. Lead from gasoline added to other sources of lead in the atmosphere is of growing concern to health authorities. The latest medical opinion is that present lead levels do not constitute a health hazard. However, there is evidence that the lead level is rising, particularly on the surface of the ground. Lead could therefore eventually become a problem if left unchecked.

### Causes of Automotive Pollution

Automotive pollutants result from incomplete burning of fuel. When there is sufficient oxygen, hydrocarbon fuel is completely converted into carbon dioxide and water vapor. Incomplete combustion also produces carbon monoxide, hydrocarbons and oxides of nitrogen.

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Incomplete combustion can occur for various reasons -- poor mixing of air and fuel, short combustion time, quenching of the combustion process near a cool chamber wall, dead space where the combustion flame can not penetrate.

Some of these problems can be eliminated by heating the air or fuel prior to mixing, or replacing the standard carburetor with a fuel injection system.

Crankcase emissions are eliminated by using a PCV (positive crankcase ventilation) valve that feeds crankcase vapors back to the air intake system to be burned in the combustion chamber.

When a car is stationary, particularly when its engine is hot, gasoline can evaporate through either the fuel tank breather tube or carburetor, becoming another source of automotive pollution. It can be greatly reduced by terminating such tubes and other outlets with an activated charcoal filter that absorbs escaping vapors. When the car engine is started, air is sucked through the charcoal filter, extracting the fuel vapors. The mixture then passes through the air filter into the engine, where it is burned.

#### Controlling Automotive Pollution

Since January 1, 1971 the control of air pollution from motor vehicles has been a shared federal-provincial responsibility. The federal government now establishes all emission standards and enforces them at the manufacturing level. Provincial governments are responsible for the control of pollution emissions from vehicles after they have been sold.

Prior to 1971 regulations controlling automotive pollution existed only at the provincial level. Ontario, in fact, was the first province to pass legislation in this area. Its initial regulations reduced pollution from 1969 model cars to 50 per cent of that produced by uncontrolled 1968 model cars. Subsequent regulations for 1970 and 1971 reduced emissions further.

Federal regulations for the 1972 model year have reduced car emissions to 20 per cent of the 1968 level. It is anticipated that this figure will be down to somewhere between five and ten per cent by 1975.

In Ontario the provincial agency responsible for the control and prevention of air pollution is the Air Management Branch of the Ministry of the Environment. The control of pollution from motor vehicles is the special responsibility of the branch's Automotive Emission Control Section.

This section works in several ways to lessen automotive pollution. It conducts research (e.g. into the possibility of adopting anti-pollution devices for pre-1969 uncontrolled cars); maintains liaison with various motor vehicle organizations (e.g. the Automotive Transport Association of Ontario with which it is attempting to reduce excessive emissions from diesel trucks and buses); operates two mobile test laboratories to carry out spot checks on 1969 and newer model cars.

The section started the spot check program to determine how well pollution control devices actually function on the road.

Maximum fine for removing or tampering with a control device is \$500.00.

#### Exhaust Control Methods

There are four basic ways of controlling automotive exhausts.

1. Controlled combustion systems involve fine tuning of the carburetor and timing mechanism to produce more efficient combustion and, therefore, lower concentrations of pollutants.

Engines equipped with control combustion systems have leaner mixtures strength, usually a ratio of approximately 14:1. The spark timing is advanced or retarded for better combustion depending on the particular mode of vehicle operation. Some of the exhaust gas is also recycled through the engine for better combustion.

2. The air injection method uses an air pump to force air into the exhaust manifold of the car engine. The temperature of the air-exhaust gas mixture is high enough to allow combustion to occur. As a result, most of the polluting gases are burnt to carbon dioxide and water vapor.

3. The fuel injection method accurately meters a fixed amount of fuel and air to each combustion chamber of the vehicle's engine. Better combustion can be achieved with this approach than with the carburetor system. Fuel injection cuts off the fuel supply completely during deceleration, a time when a carburetor causes high pollutant output.

4. A catalytic muffler containing certain types of catalysts can be used to oxidize toxic gases in the exhaust. Due to the

poisoning effect that lead has on the catalyst, however, the system can only be used with gaseous fuels, diesel fuel or unleaded gasoline.

In the past few years there have been a number of encouraging developments in the area of automotive pollution control. A large public utility has tested dual-fuel vehicles. These cars use gasoline on the open highway and either propane or natural gas in congested areas and stop-and-go traffic.

Tests have suggested that car engines using natural gas or propane can operate for considerably greater mileages between maintenance checks than those using gasoline. This is due to an absence of both spark plug fouling and engine oil dilution. However, due to problems of distribution, this type of system is only likely to be of benefit to fleet operators whose vehicles return each night to a central refuelling point. It is unlikely to become the everyday fuel for the average motorist.

#### Low-Lead and Lead-Free Gasolines

The use of lead-free and low-lead gasoline in existing vehicles is not expected to reduce emissions of the main gaseous pollutants -- carbon monoxide and hydrocarbons -- although a number of conflicting reports have been issued on this topic.

Some reports state that the use of lead-free fuel increases the emission of hydrocarbons, particularly those with high photochemical smog-forming potential. Other reports indicate that the use of such fuel will bring about a decrease in hydrocarbon emissions.

On this latter point, however, there is additional conflict whether

fuel can be low-lead or must be completely lead-free before hydro-carbon emissions are reduced.

Vehicles can be split into three groups in reference to their ability to use lead-free gasoline. In the following cases, it is assumed that a lead-free gasoline of sufficiently high octane number is available to satisfy the octane requirement of an engine as a result of its compression ratio.

1. Pre-1970 North American vehicles which have been operated for a considerable period of time on leaded gasoline possess a protective layer of lead on various engine parts. A switch to unleaded fuel should produce no adverse effects.

2. North American vehicles sold late in the 1970 model year plus 1971 and later Asian and European imports will not be adapted to operate on unleaded fuel. Use of this type of fuel from the very beginning of engine operation could give rise to severe engine malfunction. A possible solution is to operate such vehicles for a few hundred miles on leaded fuel, followed by general use of unleaded gasoline. It will probably be necessary to repeat the use of leaded gasoline at intervals to ensure a replacement of the protective lead coating.

3. 1971 and later model North American vehicles have for the most part been manufactured for satisfactory operation on 91 octane, lead-free gasoline. Use of this fuel poses no problems.

The use of lead-free gasoline will help reduce the total amount of lead being emitted into the atmosphere. In addition, lead-

free gasolines are necessary for the satisfactory operation of the catalytic muffler -- the only control device available that will enable compliance with exhaust emission standards proposed for 1975. General Motors has already stated that it intends to install catalytic mufflers on some of its 1973 cars and on all of its cars from 1975 onwards.

#### Alternatives to the Internal Combustion Engine

Possible alternatives to the internal combustion engine are an electric power source, a modified steam engine and the gas turbine.

The totally electric car is not considered a practical proposition at present. It is of necessity small because of low power availability. In addition, the considerable weight of the power source (rows of batteries) and the volume it occupies leaves both very little power and room for transportation of goods, luggage, etc.

The electric car has a top speed of about 50 m.p.h. and a small range (about 40 miles at 50 m.p.h. and 65 miles at 30 m.p.h.). As a result, it is limited to urban driving. Battery recharging time is considerable.

Possessing definite potential is the gasoline-electric hybrid. Several types have been produced on an experimental basis. Electric power is used for urban driving during which low maximum speed is not a great disadvantage. At the same time the high pollution levels created by gasoline powered vehicles while idling or travelling at low speeds are eliminated.

Outside urban areas, when high speeds are necessary, the hybrid

is switched over to gasoline. Emissions from gasoline engines are much lower at high speeds. Part of the power generated is used to recharge the batteries.

The steam or Rankine engine works on the same principle as the regular steam engine. Recently developed propulsion systems cannot really be termed "steam", however, because the water component has been replaced by various low boiling point organic compounds of the type used in refrigerators (freon, etc.).

This engine burns fuel very efficiently, producing only 1 per cent of the emissions of a gasoline engine. Speeds are comparable with those of conventional vehicles. As an external combustion engine it can burn any fuel. Kerosene is generally used.

Much development work was done on this engine several years ago. Many difficulties persisted, however, and not all of them have been resolved. This approach has lost much of the promise that it once held out as a possible pollution-free alternative to the internal combustion engine.

The gas turbine has been tested several times as a propulsion unit for the automobile. Difficulties include noise, slow acceleration, vehicle vibration and engine weight and size. Pollutant output is considerably less than that resulting from a gasoline engine and still somewhat less than that from a diesel engine. Concentration figures for exhaust components cannot be meaningfully compared, however, due to dilution of gas turbine exhaust with large quantities of excess air.

The gas turbine engine seems more suitable as a power unit for trucks and buses, and some progress has recently been made in this area of application.

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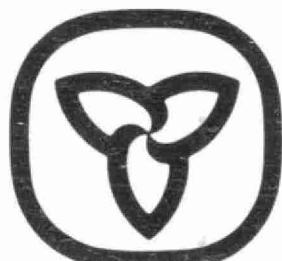
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